THE BUSINESS CASE FOR ROOFTOP URBAN AGRICULTURE

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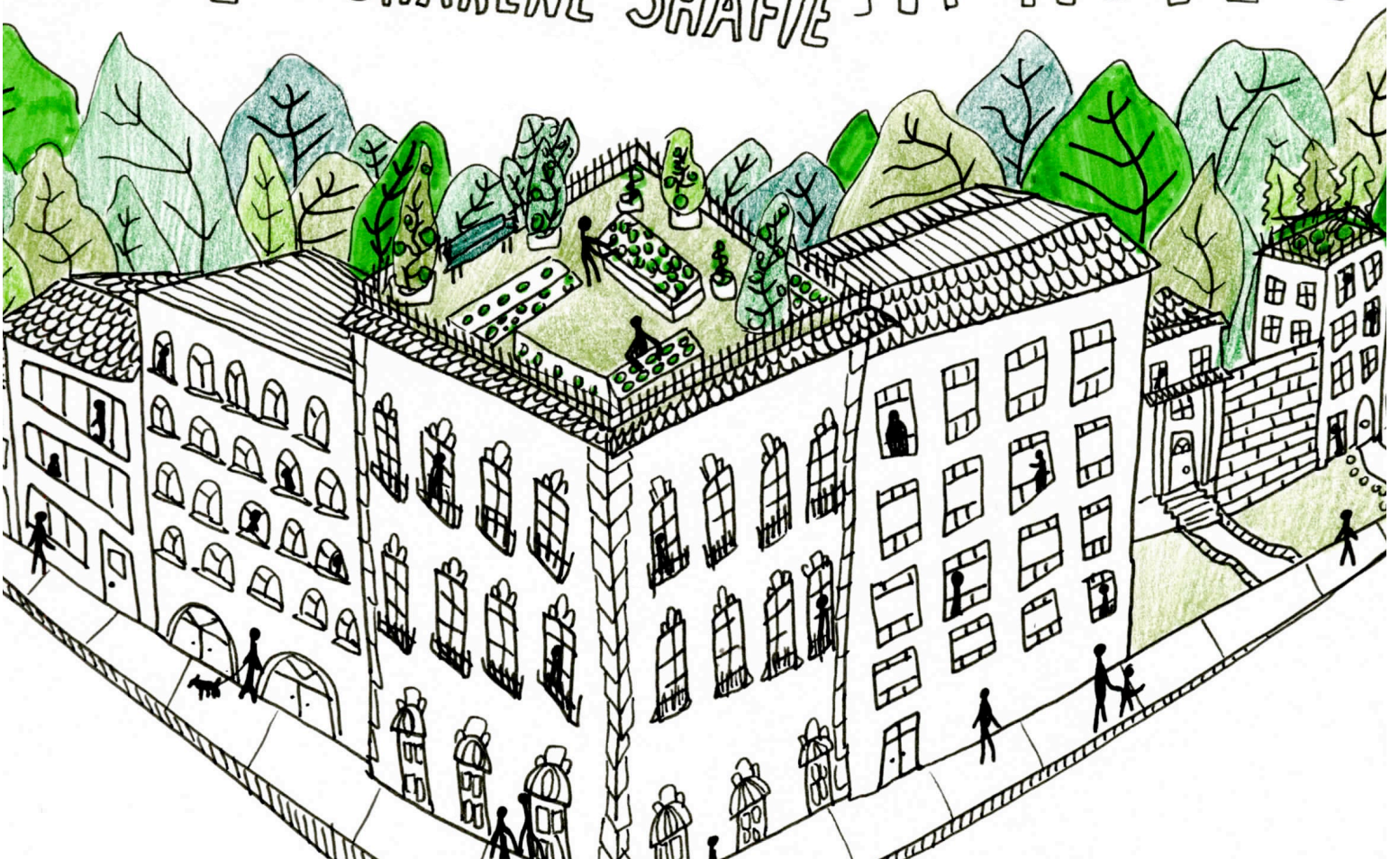

The Business Case for Rooftop Urban Agriculture

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Abstract

Our world is in crisis; with the impending doom of global warming, coupled with climbing global populations, and the growing demands of the world's increasingly urban population, the need to reimagine our current food systems is evident. Rooftop urban agriculture offers a solution to this problem, making good use of the idle rooftop space that often goes unused in cities across the globe. However, the technology's adoption seems to be stunted. In Toronto there are no solely commercial rooftop urban agriculture operations; this is surprising seeing as Toronto was actually the first city in North America to adopt the Green Roof Bylaw, which requires the construction of green roofs on all new developments over a certain size. While there has been extensive research done to investigate the environmental and social impacts of rooftop urban agriculture, the industry remains hindered. It had become clear that the technology's ability to serve as a sustainable business opportunity was unsubstantiated, ultimately impeding its implementation on a wide scale. This research uses various business design tools to theorize, test, and illustrate the potential of open-air rooftop urban agriculture to thrive as a sustainable business.

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Introduction - Sowing the Seeds

For centuries human beings lived in tribes, nomadically, it was not until about 10,000 BCE when hunter-gatherers began opting for a more sedentary lifestyle in which they grew their own food (Price, 2017). For centuries after that, humanity harboured its ability to farm in order to feed quickly growing populations. While these populations continued to expand, farmers were pressed to keep up with the growing demand for food. This demand continues to be an issue today, as the global population increased over 400% in the twentieth century (Roser, 2017). Not only has the demand increased exponentially but studies have shown that farmland is being lost at an alarming rate. Forty acres of farmland is lost to development per hour in the United States alone (FARMLAND, n.d.). This fact becomes even more concerning when paired with the knowledge that it is estimated that the world will need to grow 50% more food to sustain the nine billion people that are expected to inhabit the earth by 2050 (Milman, 2015).

The human race continues to be an increasingly urban civilization, as more and more people are drawn to city centers. Centuries ago the Industrial Revolution began to draw citizens out of their historically rural habitats in search of the prosperity that was thought to be endemic of urban life. Now with more than half of the world population living in cities, the trend has continued ever since (Collyer, 2015). There is no sign of slowing down; each year hundreds of thousands of people gravitate towards life in the city. It is predicted that by 2050 the percentage of people living in urban areas will be closer to 66% (World's, 2014). The urban sprawl responsible for the loss of the precious farmland that had been dedicated to agriculture for generations past is a direct result of this accelerating urbanity. In addition, a study done by Statistics Canada reveals that only 5% of Canada's land terrain is conducive to growing food; with Toronto's soil being some of the best the country has to offer (Acton & Gregorich 20, 1995). This is especially concerning, seeing as more than 7,400 square

kilometers of this farmland has been lost to urbanity in the last decade, an area three times the size of Prince Edward Island (Suzuki & Faisal, 2013). Our cities could soon be facing a crisis. Urbanization is causing people to become disconnected from their natural environment, and furthermore, disconnected from the systems and processes that provide us with the food that fuels us (Mayer et al., 2015).

In Canada, fewer than one in five people currently live in rural areas with the rest living in the more densely populated cities (Canada, 2017). One third of Canada's population lives in Toronto, Montreal or Vancouver (Press, 2017). The growing challenge becomes: How do we continue to sustain these growing cities? How might we educate our local populations about where and how they get their food, while providing more people with the freshest most local produce possible? A big part of this answer lies in the rise of urban agriculture. Growing more food where people live makes absolute sense; there are numerous benefits, for instance, the reduced reliance on imported food. A recent study published by the Friends of the Greenbelt Foundation, the George Cedric Metcalf Charitable Foundation, and the J.W. McConnell Family Foundation, suggests that, "if Ontario production expanded to replace 10% of the top 10 fruit and vegetable imports, the Ontario economy could benefit by nearly an additional quarter of a billion dollars in GDP and 3,400 more FTE jobs" (Cummings, Francis & Kubursi, 2015). The potential impact that producing more local food could have on our cities is huge, not only for the environment and for society but also for our economies. However, the question remains: Where? Viewing Toronto aerially on Google maps reveals the expanse of rooftop space that overlooks the rapidly growing city. It seems an unfortunate circumstance that most of this prime real estate is underutilized, when some of this space could instead be used to nourish our urban population.

The technology that I will discuss in my paper helps to address the challenge of feeding the inhabitants of Toronto, while leveraging the underutilized space in cities across the globe.

Rooftop urban agriculture is a practise that has garnered much attention in recent years, but it dates back to 600 BCE to the Hanging Gardens of Babylon (Mandel, 2013: 6). While there remains lots of variance in the ways that people today are practising rooftop urban agriculture, the general mandate remains constant. Commercial rooftop farmers are fuelled by their desire to feed local populations while benefiting the environment, with the aim of generating a profit. Even though rooftop urban agriculture has been expanding on a global scale, it seems the technology is being put into effect in some regions more than others. The city of Toronto, in particular, faces a major challenge. With the most mouths to feed out of any other metropolis in all of Canada, and with urban sprawl subsuming much of the regions' most prized farmland, the time to reimagine the city's food systems has come (Mandel, 2013: 221). Although Toronto's first commercial rooftop farm dates back to 1995, with the erection of Annex Organics, not many solely commercial endeavours such as this have emerged since (Smith, 1998). Which leads one to wonder: What are the barriers to rooftop urban agriculture's implementation here in Toronto?

Fig. 1. Garlic Sprout at Ryerson Urban Farm

While there is currently extensive research available on the numerous environmental and social benefits of rooftop urban agriculture, the question that was found to be repeatedly unanswered in my preliminary research was the economic performance of these sorts of undertakings (Golden, 2013). I have identified economic feasibility to be a major reason for the technology's lack of adoption; in view of the fact that we are living within the confines of a capitalistic society. Therefore, I have deduced that building this business case for open-air rooftop urban agriculture will help to progress the industry by providing the necessary basis for individuals who are looking to break into this burgeoning field.

This is an exciting time for those entering the sphere of urban agriculture. It is evident that there is a movement taking place. I have spent the last year of my life speaking to people about my research; on numerous occasions my passion has been shared amongst the people I have met. People are commonly excited by the prospect of urban farming, wanting to connect, to get involved, to help. I find this extremely invigorating. Even entrepreneur and philanthropist Kimbal Musk alludes to this revolution, "he sees a growing movement of young, highly educated people leaving their sedentary office jobs to become local and organic farmers" (Garfield, 2018). The question remains: Is it economically sustainable?

In the pages that follow, the history of urban agriculture, the more recent developments in rooftop urban agriculture, and the circumstances that led them both to emerge, will be laid out and detailed where relevant to this business case. I will also impart the many key resources and activities that have proven to be essential for the success of open-air rooftop urban agriculture, based on the extensive research I have done on the subject, having read countless secondary sources and having conducted interviews with a variety of industry professionals. The numerous benefits that an open-air rooftop farm provides for the building that it occupies, for its city, and also for its community will also be dictated as "impact assessments", which prospective rooftop farmers can use to help communicate the potential

of their proposed ventures. All with the ultimate goal of helping those who are looking to find economic sustainability in the field of rooftop urban agriculture. I would also like to clarify first that economic sustainability here refers to the ongoing profitability of such an endeavour in the long term, without the constant reliance on government grants or other subsidies.

Literature Review - The Field

For the reasons laid out above, I have taken it upon myself to build the business case for open-air rooftop urban agriculture. It is my hope that budding rooftop farmers across Canada, and the world, can use this research to justify starting their own enterprise. I intend to design a model that emerging practitioners alike may refer to, to gain a more comprehensive understanding of what the actual function and economics of such a venture entails. So that together we can contribute to feeding our growing urban populations; without causing further damage to our planet, all while educating citizens about our precious food systems and bettering our societies.

A Brief History

The practise of urban agriculture is not new. It has been around for centuries and can be traced back to many ancient civilizations; having existed as long as there have been cities. The practise dates back to 3,500 BCE in Mesopotamia when farmers began allocating plots to growing food within the bounds of their expanding cities (Green, 2012). However, as the distinctions between rural areas and metropolis cities became more and more distinct the rift between farming and cities only intensified. This divide was strengthened by the post-WWII cultural bias against farming, as it was perceived to be “backwards” in contrast to what was thought to be the more progressive tendencies inherent to city life (Urban Agriculture). Fortunately, the last few decades have seen a resurgence of urban agriculture practises.

Within which, there are a growing number of practises that are doing well to challenge these historically regressive misconceptions of agriculture through the use of increasingly innovative farming technologies (Skaife, 2015). This research aims to look more specifically at the progressing forms of urban agriculture, to decipher whether or not rooftop urban agriculture can indeed become a successful, sustainable, and scalable industry.

The Current Landscape

When embarking on a new venture, it is important to think about one's desired outcomes and motivations; this is especially crucial when it comes to starting a rooftop urban agriculture endeavour. This is largely owing to the fact that this line of work is not for the faint of heart. Rooftop urban agriculture is gruelling, unpredictable, and unforgiving work. Depending on how it is executed, one's harvest, and in turn one's profit, is subject to the will of Mother Nature. It is for this reason that many of those who are engaging in rooftop urban agriculture today are taking matters into their own hands, controlling the variables and reducing their businesses susceptibility to risk through the use of more high-tech innovative technologies such as hydroponics, aquaponics, passive greenhouses, vertical farming, smart monitoring systems, and more (Hardman, 2016).

Fig. 2. Photo Courtesy of Ryerson Urban Farm

Photo of BrightFarms Courtesy of Bud Glick

An example of this innovative farming technology lies right here within the institution of OCAD University. While greenhouses in the past have garnered a bad reputation, due to their high demand on energy consumption, today there are more cutting-edge greenhouses that are designed to be self-sufficient, requiring minimal inputs. Ian Clarke, Associate Dean of the Faculty of Liberal Arts and Sciences, Graduate Studies, has piloted a passive greenhouse on the roof high above the school. His Passive Solar Greenhaus relies only on heat stored from the sun and is similarly cooled by vents and a fan powered by small solar panels. Therefore, it does not require any additional inputs all year round (Clarke, 2015). Having had the opportunity to take a tour of this hundred square foot facility enabled me to understand what is possible in terms of using innovation to increase energy efficiency and productivity.

Lufa Farms is the epitome of this innovation. They have taken a lot of the variability out of their operation through the use of innovative technology. Having built the world's first commercial rooftop greenhouse in 2011, Montreal, Quebec, they are very much a for-profit company that is focused on growth. With a mission to grow more food where people live and determined to grow it more sustainably, one of the ways that they are able to reduce their environmental impact is by capturing rain water and recirculating their irrigation water (The Farm). They have grown rapidly since their inception; distributing a few hundred baskets of produce to their customers in the first summer, to over nine thousand today (YESMontreal, 2017). Lufa Farms is a prime example of the success that can be cultivated by rooftop urban agriculture when it is done in an innovative way, using hydroponics and other technology to optimize, automate, regulate, monitor, and expedite its processes. Hydroponics involves growing plants without soil, in a water based nutrient rich solution (Hydroponic System 101). But this highly commercialized example is not typical of what has historically been the case when it comes to urban agriculture initiatives, quite the contrary.

A study done of the Cascadia region in 2013, encompassing British Columbia, Washington and Oregon, found that most of the time urban agriculture arises out of a desperate need for people to feed themselves. This research shows that in the past these efforts have emerged as a response to periods of economic crisis (Nathan McClintock, and Michael Simpson, 2016: 62). For these reasons the majority of the urban agriculture organizations that exist today are not actually for-profit businesses at all: they are not-for-profits, grassroots movements, non-governmental organizations, community-based operations, schools, and other public sector initiatives. This difference in designation proves to be extremely important, as a survey showed that while the smaller number of businesses that operate in this field have a primary objective of making money, this motivation is representative of a much smaller sect of urban agriculture sector (Nathan McClintock, and Michael Simpson, 2016: 69). Thus, it has previously been a huge challenge for businesses leading this charge to prove their financial viability in this uncharted terrain. Luckily for those of us who are getting into the industry today, a lot of progress has been made. Urban farming methods and business models are being tried and tested, which adds to the growing body of evidence that points to a successful triple bottom line. The Brooklyn Grange's business model for instance is focused on this triple bottom line, which values finding a balance between human, environmental, and economic sustainability (Mandel, 2013: 177). Every day there are more and more cases of rooftop urban agriculture businesses that seem to be showing a positive return not only for the people and the planet, but also in terms of profit too. It is an unfortunate circumstance that all of the for-profit businesses that have led the charge in the industry over the past decade, do not choose to make their financial records publicly available. This omission of information makes confirming these businesses' financial sustainability challenging, which is why I have taken it upon myself to reach out to a handful of operations to gain a better understanding of their economics.

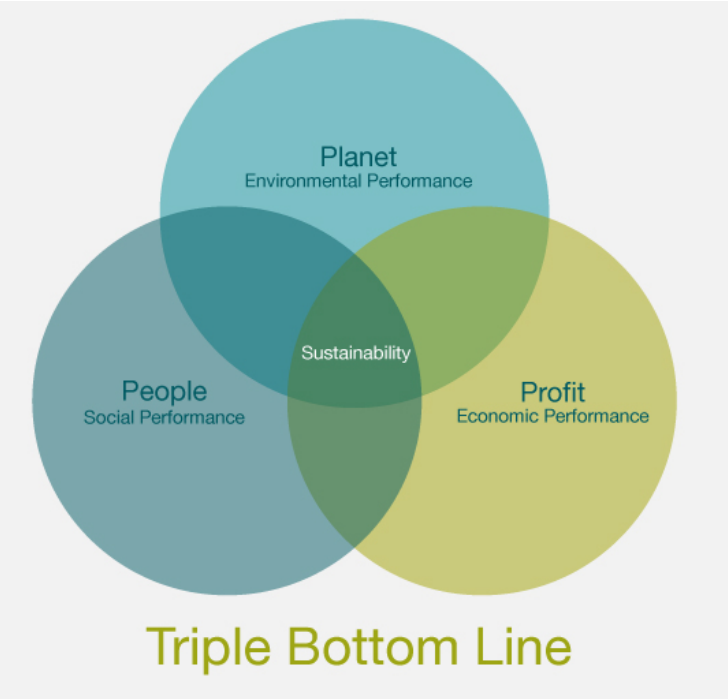

Fig. 4. Photo courtesy of FAMILY FISH FARMS NETWORK INC. ©

My research shows that rooftop urban farmers today are moving towards establishing more highly technological farms due to their seemingly high potential for success. High-tech ventures such as Lufa Farms, Gotham Greens, BrightFarms, and the host of examples that are springing up every day, are a testament to the understood potential of these models. Thus, I propose the business case has been made for these more technologically advanced kinds of operations. While it seems there are a fewer number of open-air rooftop farms emerging to find commercial success, besides a few notable examples such as the Brooklyn Grange in New York. This is unfortunate seeing as open-air rooftop urban farms offer a different range of public and private benefits that high-tech farms simply cannot match (Berger, 2013: 28). Open-air rooftop urban farms have an unparalleled ability to: bring communities together around food production, educate youth, create jobs, encourage biodiversity, reduce urban heat island effect, host events, and reconnect populations with their natural environment. This is owing to the fact that high-tech or controlled environment farms are physically closed off from their natural environment. Thus, highly technological farms are not usually able to provide this same diversity of benefits. It is for these reasons that I have reframed my research to look more specifically at “Building the Business Case for Open-Air Rooftop Urban Agriculture”.

Policy

Governments can play a major role in the success or suppression of industries. They can implement policies that actively work to support sectors or they can impose legislation that is challenging to navigate. Government funding in the form of grants or bursaries are a substantial benefit that exist in some cities, such as Toronto. In 2009, Toronto was the first city in North America to implement a green roof bylaw which requires the construction of green roofs on all new developments built over a certain size, while also providing a monetary incentive of up to $100,000 for buildings who want to retrofit their development (Green Roof Bylaw, n.d.). On the other hand, the City of Mississauga provides properties that manage their own stormwater a rebate, while charging other properties a fee for not having stormwater management strategies in place (Understanding the Stormwater Charge, n.d.). These are precisely the kinds of incentives that help to push necessary forms of development, such as urban agriculture, forward.

Nevertheless, there is research that suggests that urban agriculture businesses are not usually the ones who benefit most from governmental support (McClintock & Simpson, 2016: 73). Both John Stoddard from Higher Ground Farms in Boston and Jeremy Lekich of Nashville Foodscapes voice the need for governments to stop subsidizing industrial farming practises, to instead fund more sustainable urban farming operations. They propound that government subsidies are currently bolstering the irresponsible production of cheap, nutrient-poor, calorie-rich food (Foden, 2015: 10). Nevertheless, the consensus amongst all practitioners seems to be that governments can either have a huge positive or negative impact on the development of the urban agriculture industry.

As speaker, educator, researcher, writer, urban interventionist, and philosopher Jonathan Silver says, “Urban farming is on the rise in North America. Its rate of growth is largely

determined by supportive city policy. At best, policy is a trellis that guides and facilitates urban agriculture projects. At worst, policy stunts developments that would otherwise enhance food security" (Silver, 2015: 18). However, sometimes policy alone may fall short; a study published by the Metcalf Foundation entitled *Scaling up Urban Agriculture in Toronto: Building the Infrastructure,* suggests that even though the Toronto City Council adopted a *Local Food Procurement Policy* in 2008, there are simply not enough standards in place to regulate what is considered "local". The report goes on to note that, "shifting supply chains is proving challenging because of existing relations with distributors and the particular food requirements that exist in many cafeterias. In addition, linkages with potential urban growers are needed, and establishing these requires partnerships among NGOs, the City, and growers" (Nasr et al., 2010: 36). While policy is an imperative step in the progression of change, it is important to remember that this alone is not enough. Policy needs to be taken further into action; the most eloquently written piece of legislation is only as effective as the implementation plan that accompanies it.

Finance

Funding sources range heavily depending on the scale and location of the budding operation. Today's start-up capital raising platforms such as Indiegogo, GoFundMe, and Kickstarter, are applicable to rooftop urban farming ventures. The Brooklyn Grange accounts their successful crowdfunding campaign in the detailed telling of their story *The Farm on the Roof,* beautifully written by one of their founding members Anastasia Cole Plakias. They recount the sheer surprise and amazement they felt, as they raised $20,000 on Kickstarter, from more than 400 supporters from around the world (Plaikas, 2016: 76-78). The point being that the potential to raise capital in the world of today is greater than ever before. With each and every open-air rooftop urban agriculture business that finds success, the precedence is

being established and we move towards a more sustainable food system for our increasingly urban global populations.

A book that does well to provide some of these elusive financial details, while breaking up the world of rooftop farming into succinct categories, is the text written by Rooftop Agriculture Specialist Lauren Mandel, aptly named *EAT UP!* She breaks rooftop farming into 3 categories: rooftop gardens (small-scale), rooftop farms (medium-scale), and rooftop agriculture (large-scale). She also indicates the various funding strategies that some rooftop farming operations have used, such as self-finance, loans, investors, equity investments, grants, crowdfunding, and funding from a parent company (Mandel, 2013: 189). While Mandel does provide relevant examples for each of these funding methods, she does not explain them nor does she provide the positives or negatives of each strategy. It seemed to me to be a very small chapter for what is such a major determinant of success for these farming operations. It has the potential to make or break one's business, securing funding can be the difference between starting a venture or not.

The beginning chapters of *EAT UP!* provides an explanation and brief background on rooftop urban agriculture and the chapters that follow are broken up into the 3 size classifications she specifies, giving examples for each, along with a checklist of what she has deemed necessary components of a rooftop farm. Within her chapter on large-scale agriculture, her checklist breaks down financing into 4 parts: triple bottom line, business plan, profits and payback period, and funding opportunities. These are topics I had decided to include in my research in order to build the business case for rooftop urban agriculture. Mandel explains how profit margins, upfront costs, and long-term costs can vary considerably depending on a company's production strategies. Making clear the fact that urban farming businesses deploying high-tech strategies often enjoy much greater and consistent yields, at a much higher initial cost than low-tech rooftop farming companies, which require substantially less upfront capital

investment. In her book, she recounts a conversation that took place at the 2012 Agriculture Summit. Co-founder of Lufa Farms, Kurt D. Lynn, and Brooklyn Grange's president and head farmer, Ben Flanner, divulged their initial investment costs versus their long-term payback plan. Lynn stated that although their high-tech hydroponics farm cost roughly $71 per square foot to install, their average payback time was only three to five years. This differs greatly from the $5 per square foot that Flanner estimated his open-air rooftop farms cost to install, but with a payback period twice as long of approximately ten years. Mandel suggests that determining what kind of farm to start depends heavily on how much initial investment can be secured and what one's payback goals are. Her book also cites forging relationships as a key strategy for the success of any rooftop farming operation. The relationships that she references in her book are between urban rooftop farms and: research institutions, food aid, food distributors, community education, and outreach. Building these relationships can also help in funding the projects as partners can serve as invaluable investors.

One of the most prominent examples of a partnership between a rooftop urban farm and a grocery store exists between Gotham Greens and Whole Foods Market. With their doors officially opened in 2013, the greenhouse farm spans 20,000 square feet of the grocery store's rooftop. The health food corporation launched their first ever Brooklyn location and asked Gotham Greens to join them in opening one of the first-ever grocery stores with a rooftop farm in all North America. Together they are able to educate the public about the latest technologies in local food production, sustainable energy, water reuse, and conservation (Gotham Greens, n.d.). It is clear to see how this partnership is so mutually beneficial. Not only does it provide Gotham Greens with a highly efficient and direct sales channel by which they can sell their produce, it gives Whole Foods the freshest supply of local produce possible, grown right upstairs, with minimal transportation costs and environmental impact. Gotham Greens is also able to offer Whole Foods Market the social cachet of working with such a forward-thinking enterprise; again emphasizing the importance of these symbiotic

relationships. Some believe this social capital is actually more important than the monetary value that this kind of operation brings (Plakias, 2016: 59).

In the book The *Farm on the Roof* Plaikas speaks about the importance of having diversified revenue streams. For this reason the Brooklyn Grange engages in a number of profit generating activities beyond merely selling produce. They quickly realized the need to utilize their space to its maximum potential by offering their beautiful rooftop farm as an event space. They also lend their expertise as consultants to help others design and install green roof projects (Plaikas, 2016: 210). An open-air rooftop urban farm is put in an unnecessarily precarious position if they rely solely on the funds brought in from selling their produce to sustain their business. In the case that one's harvest was in jeopardy, due to inclement weather conditions or disease, the effects on one's business could be detrimental, whereas this would not be as severe an issue for a business that had additional means of generating revenue. Similarly, investors would be deterred by these high-levels of risk, and so it is truly in an open-air rooftop farm's best interest to diversify.

Mandel reiterates the need for farms to diversify; not only in terms of their revenue streams but also in regards to their distribution channels. The logic behind these strategies being the same: having multiple means of generating revenue and having more than one way to distribute one's produce helps to ensure financial stability (Mandel, 2013: 112). Being that farming remains one of the most financially vulnerable businesses today, these types of risk mitigation strategies are of the utmost importance (Plakias, 2016: 210). Another way that farming operations are able to alleviate some of this risk is by selling their produce through what is known as a 'CSA program', which stands for Community Supported Agriculture. This distribution channel involves, the presale of produce baskets that are then either delivered or picked up by subscribers at predetermined pick-up points on a regular basis, usually weekly (McClintock & Simpson, 2016: 67). This is a distribution method that a variety of rooftop

urban farms choose to engage with, such as Lufa Farms, Ryerson Urban Farm (RUF), Brooklyn Grange, and Eagle Street Rooftop Farm, to name a few. This sales strategy is ingenious. It allows rooftop urban farms to minimize their risk by receiving payment from subscribers at the beginning of the season when budgets may otherwise be tight. This upfront payment helps to boost a farm's cash flow so that they might afford their necessary business expenses, which inevitably contribute to the success of their operation. This is most likely why the study done of the Cascadia region, found that most businesses surveyed had adopted CSA programs as a primary distribution model (McClintock & Simpson, 2016: 67).

Another thing that a farm can and should do to generate additional revenue is to host bees on their open-air rooftop farm. There are currently companies that will help you install and maintain apiaries, which is the place where bees are housed. Launched in 2012, Alveole's business is all about spreading their love of bees. The company offers to run educational sessions to help acquaint occupants with their new neighbours; and have successfully implemented hundreds of hives across Quebec and Ontario. Hosting bees on one's farm is something that most rooftop open-air urban farms do; purchasing a system would cost roughly $300, for both installation and training (Services, n.d.). Mutualism, "the doctrine that mutual dependence is necessary for the good of social well-being" (Mutualism, n.d.). This ideology is certainly the case when it comes to bees. In an effort to mediate the declining global bee populations, in return for providing bees a safe place to flourish, they naturally provide the essential service of pollination back to the farm. While some may think that cities are not an ideal place to host bees Alveole proposes that it is, "truly the best place for bees: there are strict anti-pesticide laws, untapped floral diversity and largely unused rooftop space" (The Invisible Urban Worker, n.d.). This is why having an active apiary is beneficial for not only the rooftop open-air urban farm, but also for bee populations. The production and sale of honey can also serve as an additional revenue source for the farm.

When it comes to managing one's expenses, one of the largest ongoing costs that an open-air rooftop farm incurs is labour. Human power is expensive and running a successful open-air rooftop farm often requires a lot of it. The research conducted on the Cascadia region, found that "three quarters of surveyed organizations rely on ten or more volunteers per year", whereas half of the businesses reported relying "tremendously" on volunteerism, with more than half relying on five or fewer volunteers a year (McClintock & Simpson, 2016: 74). While it is not sustainable to rely solely on the merits of volunteerism in the long term, it is a strategy that many non-profit organizations and businesses both engage with. In an industry where finances are tight, it is imperative to save costs in every respect and to boosts revenues wherever possible.

Impact Assessment

The benefits of rooftop urban agriculture are also becoming better represented. Not-for-profit organizations working to strengthen the open-air rooftop urban farming industry, such as Green Roofs for Healthy Cities, are creating tools that can be used by rooftop farming entrepreneurs to help quantify the impact of their operation. The tool that is being referenced here, called the Cost Benefit Matrix, was not designed specifically for rooftop farming but rather aims to quantify green infrastructure benefits on a wide scale. Its development is the result of more than five years of work and research conducted by Smart Cities Research Services for the Canada Mortgage and Housing Corporation (Tomalty et al., 2010). This tool helps to quantify what have been deemed the 'hard' benefits that a green roof intrinsically provides governments, land developers, and business owners. These 'hard' benefits can be more easily measured than what are referred to as 'soft' benefits, like: the long term impact on population's mental health, for example. This tool provides financial estimations for both private and public benefits, such as: energy savings, urban heat island reduction, stormwater management, and number of jobs created. These figures are generated based on the green

roof surface area that is entered into the tool. The program will also generate an estimate for how much one's installation and maintenance costs will be. It will provide a rough evaluation for the amount of revenue that can be generated from food production on the green roof, based on the specified size.

This tool was preceded by research done at Ryerson University in 2005, by professors Hitesh Doshi, Dr. Doug Banting, Dr. James Li, and Dr. Paul Missios. Their report entitled *Environmental Benefits and Costs of Green Roof Technology for the City of Toronto* has undoubtedly spurred much of the progress and further research that has been done on green roofs in the City of Toronto. It evaluates many of the estimates generated by the tool such as energy savings, stormwater retention, job creation, and urban heat island reduction, while also providing insights on benefits such as noise reduction, air quality, biodiversity, health, property values, aesthetics, and roof life-cycle cost assessment (27-31). The report also does well to determine the total land area of Toronto, relative to its total building area (21%) and its total building roof area that would be able to support green roofs (8%)(49). Based on these findings they were able to calculate the cost savings that the city would reap, $21,000,000 dollars a year (59). Making these impact assessment known is of huge importance, which is why this report and the Cost Benefit Matrix are both so vital in helping to progress both the green roof industry and the open-air rooftop urban agriculture industry, as they help to demonstrate the technologies' vast potential.

Other environmental and social benefits that have been discussed in the literature include: urban heat island reduction, stormwater run-off mitigation, reduced air pollution, increased biodiversity, reduced food miles, community engagement, improved food literacy, mental and physical wellbeing, increased consumption of fruits and vegetables, job creation, increased property value, and aesthetic appeal (Berger, 2013: 3; Golden, 2013: 8). While the range of benefits that a variety of urban agriculture projects generate are broad and valuable,

their inability to be quantified makes them difficult to track, record, and communicate. This is why tools such as the Cost Benefit Matrix, which are helping practitioners to attribute values to their business's operation is instrumental in the progression of the open-air rooftop farming industry.

Conceptual Framework

The aim of my research is to create cohesion between the high-level information I have derived on the financial functions of some established rooftop farms and the quantifiable benefits that they provide both public and private stakeholders. I intend to derive more comprehensive data pertaining to what a rooftop farms most essential assets are so that I may extract what an open-air rooftop farm's major business expenses are. In order to determine whether or not the revenue generated, coupled with the financial returns that a rooftop farm inherently offers, justifies the high-cost associated with starting and running such an operation. All in an effort to determine whether or not there is a business case to be made for open-air rooftop urban farming here in Toronto. While there is an abundance of information that currently exists on the many aspects of rooftop urban agriculture, I intend to uncover more in-depth data about the specifics of their economic activity so that the gaps that currently exist in their business model might be made clear.

My conceptual framework suggests that an open-air rooftop urban farm may succeed if the locale's policy supports it, if the project is able to secure the necessary funding, if mutually beneficial partnerships are established, if one's potential impact is understood, and if revenue streams are diversified. If all of these aspects are understood and executed effectively, I have theorized that such a business has the potential to find great success. I intend to engage with research methods that will enable me to derive this hard to find information, as there seems to be a major lack of transparency when it comes to the economic activities of rooftop

farming operations. Once this data has been collected I will either be able to confirm or deny the conceptual framework that I have hypothesized.

I will then be able to use these disparate components to design a business model that will need to be substantiated by these financials. Through a process of financial modelling, I will be able to determine if there is indeed a business case to be made for open-air rooftop urban agriculture. My hope is that rooftop farmers will be able to refer to this model as they look to develop their own businesses, to better understand how the economic structure of their business will work. Understanding these financials is of paramount importance when engaging with any business, and these kinds of economic breakdowns based on primary data is lacking in the literature, as most are currently based on modelled projections (Golden, 2013: 8).

Research Methodology

The history of qualitative research, unlike the history of urban agriculture, does not date back nearly as far in time. This method of inquiry is rooted in linguistics rather than numerical data and was therefore not has not been as highly regarded as an effective data collection tool until the late 1960s. Prior to this, qualitative research was thought to be limited in its ability to derive accountable data and precedence was always given to quantitative modes of investigation (Diriwächter, Rainer, & Jaan Valsiner, 2006). However, the period that followed marked the rise of qualitative inquiry implementation in empirical journals, along with the fall of the previously irrefutable academic reliance on quantitative data collection and analysis (Alasuutari, 2010). It was after this point that the scientific value of qualitative research was theorized by phenomenologists, grounded theorists, discourse analysts, narrative researchers, and others in the period between the late 1960s to 1990 (Wertz, 2014).

Furthermore, the result was a more diverse body of inquiry methods that could then be used in conjunction.

While there are many accepted definitions of what qualitative research is and what it aims to do, there is one in particular that I feel is the most appropriate, especially in regards to my own research. In the text *Qualitative Research Practice: A Guide for Social Science Students and Researchers,* editors Jane Ritchie and Jane Lewis state that qualitative research has "aims which are directed at providing an in-depth and interpreted understanding of the social world of research participants by learning about their social and material circumstances, their experiences, perspectives and histories". I identify with this definition because it aligns well with the intention of my research. I seek to uncover interviewee's individual lived experiences and insights to inform whether or not there is a business case to be made for open-air rooftop urban agriculture.

Today, interviews remain the most prominently practised form of qualitative inquiry (Atkinson & Silverman, 1997). Interviews in general are an inherent part of our modern society: from job and medical interviews, to interviews to be admitted into schools, we interview witnesses, celebrities, politicians, and criminals alike. We live in a society filled with interviewers, the practise is not reserved solely for journalism students, quite the contrary; we are interviewed by medical practitioners, religious representatives, canvassers, and friends. Living in the Information Age, we have become a society obsessed with data and we extract it in the best most natural may we know how, through the art of conversation. Human beings have been using their most innate and powerful tool to derive information for centuries, to put it simply "Interviewing may be defined simply by a conversation with a purpose" (Berg, 2009). This interpretation of interviewing is what attracted me to the data collection method in the first place. I feel very comfortable speaking with people and have a natural ability to manoeuvre conversations, which is why I was inclined to use this as my data

collection method. It was my hope that the comfort ability I would create between myself and the interviewees would allow me to gain their trust so that they might feel more inclined to share some private financial details with me.

While there are a host of interview formats and strategies, semi-structured interviews are the most commonly practises. Semi-structured interviews offer a compromise between the more rigid alternative of structured interviews and the seemingly overwhelming chaos that is unstructured interviews. They allow for the natural flow of conversation, while ensuring that all of the interviewer's desired subject areas are covered (Dörnyei, 2007). These are some of the reasons why I have chosen to conduct semi-structured interviews as my primary research methodology. I appreciated the freedom that it has afforded both interviewees and myself. I have found semi-structured interviews to be a hugely successful interview strategy as it has allowed for the steering of conversation, without inhibiting the emergence of unanticipated dialogue.

After doing extensive research in the field of urban agriculture and more specifically rooftop urban agriculture, I was able to identify who these key stakeholders are by thinking about who might be involved in the process of establishing a rooftop farm, from its conception to its ongoing operation. This list of stakeholders and as such my list of interviewees include rooftop farmers, policy makers, an urban planner, developer, not-for-profit representatives, and the owner of a green roof design and installation company. Due to the fact that I am looking at the context of Toronto all but two of my interviewees have been situated within the GTA. I only looked to interview people outside of this prescribed area when I could not find a spokesperson from within the Toronto locale. I set out to interview at least one person from relevant categories of interest, intending to conduct between seven to ten expert interviews in total, to ensure that I had a detailed understanding of the full scope of the industry. I succeeded in interviewing at least one person from each of these disciplines and often one

interview would lead me to my next interview candidate, which certainly helped me to acquire new interview candidates. This method of interviewee acquisition is called 'snowballing' and it is an established strategy for finding research subjects (Atkinson & Flint, 2001).

Each candidate was initially contacted through a request for interview email, which was then followed up by an email including the consent form I had formulated. This consent form was filled out and given back to me before the commencement of all other interview activities. Whenever possible these interviews were conducted in-person, however, when this was not a convenient option a phone interview was proposed. All interviews were recorded using a Voice Recorder app on my cell phone. Interviews lasted anywhere between twenty to forty-five minutes depending on how much time each candidate had available. In-person interview locations were chosen solely based on what was convenient for interviewees (Oltmann, 2016).

This research methodology was chosen based on my desire to derive somewhat confidential business information. Like previously stated, there is meagre data publicly available on the financial models and performance of today's rooftop farming operations. Therefore, I thought it would be best to build a rapport with interviewees, so that they might feel more comfortable sharing some of this seemingly sensitive information with me.

These interviews were then transcribed and read over. After which point themes were derived and amalgamated into primary themes, based on the content and the context of the interviews. This approach to qualitative data analysis is referred to in the literature as 'content analysis' (Ritchie & Lewis, 2003). With this method in mind I was cognizant of how many times these themes emerged throughout the course of reviewing the data. I deduced the more reoccurring themes to be of higher importance than the ones that appeared less frequency. Due to the limited size of the industry today, it was expected that I would be

interviewing individuals who had already been written about extensively in literature. Nevertheless, the intention was that I would find deeper insights than what had previously been derived, especially in regards to the financial goings on of these rooftop urban agriculture businesses.

Interviewees

The paragraphs that follow introduce each of my chosen interviews. In each of these brief biographies their occupations and experience is explained. I have also explained their specific relevance to my research and their relation to of rooftop urban agriculture in general. As previously stated, I have interviewed one or more persons from each of the research subject categories I had determined prior to beginning the data collection phase of my research.

Austin Jai - Jai is the Marketing and Finance Manager for real estate development company, The Ridgeway Group, which he co-founded in 2013 along with two other founding members. When asked about the purveyance of rooftop urban agriculture in his company's practise, he explicitly said it was something he and his company had "pushed ourselves away from very quickly". He explains that the inclusion of urban agriculture is something that the City of Mississauga makes a point to ask them about when they are in the midst of a new development. Though it is not something the city currently legally mandates, they still insist on merely asking the question. When pressed about why he thinks this might be, he denotes that their inquiry is likely due to the fact that all of The Ridgeway Group's developments have taken over farmland.

Craig Cal - Cal has worked as an urban planner for Urban Strategies Inc. for nearly eight years. Urban Strategies Inc. is a premiere urban planning firm who has an international reputation; recognized worldwide for their ability to address a diversity of urban challenges.

Cal secured his Bachelor of Arts degree in City Studies and Society & Environment from the University of Toronto Scarborough sand then proceeded to complete a Master's Degree in Planning from the University of Toronto. Passionate about cities and the people who inhabit them, he works with non-profit organizations on and off the clock to help them with their planning needs. He has witnessed the power of policy first hand, noting the vast number of projects he has worked on that have included green roofs as a result of the green roof by law of 2009. While he has not yet seen the implementation of a rooftop farm as such, he suggests the prospect is not farfetched.

Mark Winterer - The owner of Recover Green Roofs a green roof design and installation company based out of Boston. Having received his BA in Writing and Studio Arts at St. Lawrence University, before completing his MBA at Vanderbilt University - Owen Graduate School of Management. While not all of the projects his company installs are green roofs equipped for farming, I wanted to speak to him specifically about a green roof that his company designed and installed in 2015 at Fenway Park in Boston, Massachusetts. This project utilizes a technology he referred to as Recover Area Medium Modules, which are essentially a network of milk crates with embedded irrigation systems that support the growth of vegetative plants within them.

Ben Flanner - Recognized as one of the most influential individuals in the rooftop urban agriculture sector, Flanner paved the way for future urban rooftop farmers back in 2009. Having studied Industrial Engineering at the University of Wisconsin, he spent many years working as a business consultant, helping companies to become highly efficient. These are skills that he would take with him when he founded the world's first open-air rooftop farm, the Brooklyn Grange. He, along with a small team of co-founders, decided to quit their jobs in pursuit of what they believed to be a more fulfilling vocation. Since they opened their first location in 2009, they have been hugely successful, growing over 50,000 lbs of produce every

year. Now having been in the industry for more than a decade, he and his team are in the preliminary stages of opening their third location (Porpora, 2018).

Arlene Throness - In an industry dominated by men, Ryerson's Urban Farm Manager, Throness, and her fully female farm crew, are a testament to what female power is all about. Having studied Urban Agriculture at Ryerson's Chang School, she also holds a Bachelor of Arts from Concordia University where she was the coordinator of Concordia University's Rooftop Greenhouse and a founder of its City Farm School. She discovered this opportunity after having just completed the Permaculture Design Course from Linnaea Farm on Cortes Island, British Columbia. Her passion for permaculture was not only evident in the discussions we had, but also in the ongoing operations of Ryerson Urban Farm.

Shayna Stott- Stott did her undergraduate degree in what she deemed to be "kind of a make your own degree" program at the University of Guelph. Even though she was officially in the International Development program, her interest was in Environmental Science. Over the years she had a variety of interests that she then narrowed down to the intersections of climate, health, and the urban environment. This became her focus when she was doing her Masters in Environmental Policy and Planning at the University of Toronto. Although her focus was not specific to green roofs, she learned more about the environmental challenges of urban centres and the various strategies to tackle them. Now she works as an Environmental Planner in the City Planning Division for the City of Toronto, and has been overseeing the implementation and development of the Green Roof Bylaw, legislated in 2009.

Steven Peck - Peck received his Bachelor of Arts in Philosophy and Economics from McGill University. His history working in public policy, as it relates to environmental technology innovation and diffusion, while also doing extensive research about urban sustainability, has led him to where he is today. He founded the not-for-profit organization Green Roof for

Healthy Cities, an industry association dedicated to supporting the green roof and wall industry across North America in 1999. Green Roofs for Healthy Cities is responsible for organizing two annual conferences, while also running an accreditation program for their Green Roof Professionals, and offering ongoing training, workshops, symposia, and tours.

Emma Tamlin - Tamlin received her Bachelor of Environmental Sciences, International Development from Waterloo University. She currently works for Green Roofs for Healthy Cities as their Communications Coordinator and also serves as the Assistant Editor of their quarterly publication, the Landscape Architecture Monitor. Very active in her community, Tamlin was also chosen to be the Education Committee Co-Lead for the Toronto Youth Food Policy Council and has most recently volunteered at the second annual Aglanta, urban agriculture conference. She considers herself to be a budding urban food systems strategist; she is passionate about reshaping our city's food systems.

Brandon Hebor – Having gone to York University for Environmental Studies, Hebor then pursued a Bachelor of Science at McMaster University in Environmental Science, followed by Post-Graduate studies at Seneca College in Green Business Management. Since then, he and his partner founded Ripple Farms Inc., a modular aquaponics operation housed within shipping containers. As the Co-owner and Operations Manager of Toronto's most innovative vertical farming enterprise, you can find Hebor speaking at events all over the city. Ripple Farm's first location can be found on the grounds of Evergreen Brick Works, they have just launched their second and largest location on Seneca's Newham Campus.

Design Tools

In addition to having conducted interviews, I then utilized a selected number of design tools that enabled me to map, design, theorize, and test the business model for open-air rooftop

urban agriculture, based on the findings of my data collection. These tools that I have selected include the Cost Benefit Matrix tool, the Business Model Canvas, and financial modelling principles. Together they will help me to integrate my findings into a functional and sustainable business model, which I can then share with others.

The Cost Benefit Matrix tool was developed by the not-for-profit industry association Green Roofs for Healthy Cities. They have spent the past five years developing this tool, which helps to quantify both the public and private benefits of green roof technology. Developed to help policy makers better understand both the cost and benefits associated with the development of green infrastructure in their community (Crauderueff et al., 2015). Based on a given green roof area, the tool will estimate practical costs for both the installation and maintenance of the green roof, while also generating values for impacts such as stormwater management, energy savings, urban heat island reduction, number of jobs created, and potential revenue earned from food production (*Green Roof Design and Installation*, 2013).

Millions of people have used the Business Model Canvas (BMC) Tool proposed by Alexander Osterwalder, to design, describe, pivot, challenge their business models (*Strategyzer*, n.d.). Made up of the nine essential building blocks that make up any successful business: Customer Segments, Value Proposition, Channels, Customer Relationships, Revenue Streams, Key Activities, Key Resources, Key Partnerships, and Cost Structures. These nine blocks encompass four essential areas of a business, which includes: customers, offer, infrastructure, and financial viability (Osterwalder & Pigneur, 2010). However, the standard BMC format alone will not be sufficient in communicating the value that such an open-air rooftop farm brings because it intrinsically offers so much more beyond merely the monetary value. There is another variation of the BMC known as the Flourishing Business Model Canvas that goes beyond to include the greater context within which one's business operates; to account for its environmental, social, and economic impacts (Flourishing Business Model

Canvas, n.d.). I intend to employ a variation of these BMCs to design a model that will clearly communicate the value that an open-air rooftop urban farming venture generates. Dissecting these operation into these prescribed sections will ultimately help me to understand how these sorts of businesses create, deliver and capture value so that I may be able to communicate this value with the masses, so that more individuals may fund, support, and start these types of businesses.

Finally, using financial modelling principles, which involve calculating data collected from research participants, the primary software tool that is used in this method is spreadsheets (Financial Modelling, 2016). These spreadsheets will ultimately determine the financial sustainability of open-air rooftop urban agriculture businesses. This will then serve as the economic basis that aspiring open-air rooftop farmers may use to substantiate the potential of their business to investors, landlords, property managers, and other key decision makers. Understanding and communicating these financials clearly is imperative to the establishment of any successful business operation, which is why I have taken it upon myself to compile this data so that I may design and comprehensive business model that will propel this industry forward.

Findings

The findings portion of this document will elucidate the findings that have been gleaned from the interviews I have conducted with industry professionals. Although I had already derived a great deal of information about these operations from secondary sources, my research aimed to uncover greater depth about how their businesses actually functioned and the economics behind them. While much of this information paralleled what was already uncovered in my literature review, certain aspects were given greater emphasis and some financial details were disclosed. Having these points emphasized helped me to determine the various sections of

my analysis chapter. The following will be broken into several subsections: High-Tech vs. Open-Air Rooftop Farming, Physical and Non-Physical Assets, Partnership, and Impact Assessment, where appropriate my findings will be compared to what had already been uncovered through the literature.

High-Tech vs. Open-Air Rooftop Farming

It is an exciting time for rooftop urban agriculture, with the rise of vertical farming, aquaponics, hydroponics, and the like. Every day there are new examples of these technologies popping up around the globe. From the pioneering open-air farms that dawned the rooftops of New York City nearly a decade ago, to the more highly technological farms of today. Technology is reshaping our food systems and thus creating possibilities that have never existed before.

Fig. 5.Photo of Eagle Street Rooftop Farm Courtesy of Annie Novak

With the ever-evolving range of options that are available to those entering this burgeoning field the question then becomes, is there one mode of production that is better than the rest? While rooftop urban agriculture is a form of technological advancement in its own right, my research shows a major divide in the industry. This divide exists between urban farmers utilizing more traditional agriculture techniques, such as permaculture, crop rotations, composting, cover crops, integrated pest management systems, seed saving, et cetera, and those employing the more innovative aforementioned techniques. While there are projects that use a combination of these methods, the examples that currently exist in the market indicate that most projects live in predominantly one camp or the other. Which may lead a budding rooftop farmer to wonder, is one method better than the other?

The answer is not so simple, one must first ask themselves what they hope to achieve. If the goal is to be highly productive, profitable, efficient, and environmentally sustainable then the answer is to start a more high-tech enterprise. If one's goal is to educate populations, engage communities, and create an environmentally harmonious operation then the answer is to establish an open-air farm. Both of them serve a purpose in reshaping our current food systems, both of them have the potential to effect positive change in the urban environment, in deterring stormwater runoff, lowering the heating and cooling demands of buildings, and bringing hyper-local produce to more people. Certainly having both kinds of methods will be essential in changing city's food systems, together they will make up an ecosystem that will collectively reshape the way that cities feed themselves (Peck, Interview 2018).

That being said, it has become apparent through my research that the highly technological side of rooftop urban agriculture is the more commonly adopted mode of production. When speaking with industry expert Steven Peck about why this might be he replied, "Well if you look at the short term history of agriculture and research, the R&D drive has been towards

greater yields in whatever the planting context was… If I have an acre worth of rooftop space and I can either grow $50,000 worth of produce versus $100,000 worth of produce, which one do you think I'm going to opt for? Productivity is a big driver the horticultural sector. It's a natural evolution that has come from horticultural research, in an effort to become more economically sustainable. Plus if the production side of the equation is not primary then there has to be other things that substitute from an income perspective" (Peck, Interview 2018). Accordingly, much of the investment in this field ends up funding projects that is in keeping with the extensive research that has been done on creating highly-efficient and productive operations; ones which provide the least amount of risk with the highest potential for return on investment (Peck, Interview 2018). As previously mentioned in the literature review the payback period is also much shorter for high-tech farming operations; this is an attractive feature that ultimately lures both investors and entrepreneurs looking to get into the industry (Mandel, 2013: 188). This is not to say that there are a negligible number of open-air farms entering the market, nor is this suggesting that success cannot be found in what some believe is a more holistic business practise, it is merely a telling sign that the industry is moving in a more high-tech direction. It is worth noting that both open-air and high-tech farms were contacted when I was undergoing the process of securing research subjects and no one from the more technologically advanced operations was willing to set up an interview with me.

Key Resources and Key Activities

Another theme that has become apparent through my research was the need for certain key resources and activities that work together to ensure an open-air rooftop urban farm's success. Through the qualitative analysis of interviews done with various industry practitioners, I have been able to distil what the key assets are that enable the optimization of any open-air rooftop urban farm. Harbouring these assets will help to build a solid

foundation for any new venture, as employing them has proven to be a guarantor of success. These assets are essential given their collective ability to help protect businesses, ramp-up their production, minimize their losses, and maximize their potential. This list includes a collection of time-honoured techniques, that when coupled with the help of modern day technology, leverage a wealth of knowledge that can be used to optimize one's operation. While it has been noted that having all of these resources and activities are rather essential, I will elude to some alternatives, as well as suggest which could be sacrificed if absolutely necessary.

In my interview with Brooklyn Grange co-founder and President Ben Flanner, I was able to gain valuable insights about what he thought a rooftop farm's most vital assets are. Gaining these insights from one of the most highly regarded rooftop farmers today was invaluable. My final question to him at the close of our interview was, "What would be your one piece of advice be for a budding rooftop farmer?" to which he answered, "The company has certainly been a lot more successful with our diversification, and I would definitely recommend that to any farm or farmer" (Interview, Flanner 2018). I see great value and comfort in diversification of farms, especially if they are beautiful places that can have other values besides just by the actual carrots that are being pulled up". Prior to my interview with Ben, the major takeaway I derived from reading the Brooklyn Grange's informative novel was the need for diversified revenue streams. While Flanner suggested that their farm could survive solely on the sale of produce alone, he expresses the necessity for farms to expand their offerings as a form of income insurance. Running an event space, offering consultation services, educational workshops, and other congruent offerings, which do not require a significant amount of additional resources, can help to protect one's business. He shared that the Brooklyn Grange hosts an average of 115 outdoor events per year; this includes workshops, yoga, dinners, weddings, and more (Flanner, Interview 2018). With events costing anywhere from $2,500 for events up to three hours long and up to seventy-five guests

to $10,000 for all-day events with up to a hundred and fifty guests. Having this kind of additional revenue source is absolutely essential in creating a financially sustainable business. Relying on the success of one's harvest alone puts a farm in a unnecessary position of risk. This risk can be seen as too large a liability to potential investors, which is why having these risk mitigation strategies, is an absolutely essential asset for any rooftop open-air urban farm. While this corresponds with what was found in the research it was essential to get some of these figures from Flanner so that I may be able to add it to the financial model that I was designing to clearly verify the financial sustainability of open-air rooftop urban farming operations.

Fig. 6. Ryerson Urban Farm

In contrast, RUF, one of the only open-air rooftop farms in Toronto, boasts gross revenue of $40,000 in 2017 (Throness, Interview 2018). Their focus, in addition to selling the produce grown on their quarter-acre farm, is also education. Being run out of an educational institution affords them the ability to offer training courses with much ease, due to the fact that their current facilities within Ryerson University contains the necessary infrastructure to support running courses. Therefore, education remains at the core of their mandate. Nevertheless, this goes to show that sometimes one or two revenue streams alone will not be

enough for a business to turn a profit. Throness admits that RUF is still only able to generate enough revenue to cover about a third of their operational costs. Hence, the farm relies heavily on Ryerson University, their parent educational institution, and could not currently function independently from it. Consequently, RUF's reliance on volunteers is very high, which is in keeping with what was stated in the literature. Both RUF and the Brooklyn Grange have placed heavy dependence upon the use of unpaid help at one stage or another; whether it is to help with the physical farming labour, marketing, CSA basket distribution, or more. Thus making volunteers another essential resource for the establishment and ongoing operations of any open-air rooftop urban farming business. Furthermore, it is essential for these kinds of operations to establish a network of volunteers that they can rely on and reach out to when the need arises.

The Brooklyn Grange relied heavily on the support of volunteers in their earlier stages of development. When speaking with Flanner about the farm's current relationship with unpaid staff, he replied that now having had many successful growing seasons, they are proudly able to pay all of their workers (Flanner, Interview 2018). RUF, having only had their first full growing season in 2014, have had nearly thirty volunteers on their recurring roster each year (Ryerson Urban Farm, 2017). This is in addition to the help they have from the 20 or so students undergoing their Ecological Market Garden Training Course each season. This just goes to show the possibilities and differences between a farm that has been operational for almost a decade and one that has only seen four growing seasons. The hope is that all rooftop urban farming businesses will eventually be able to compensate all of their staff for contributing to the daily operations of the farm.

As the operations grow and stable revenue is consistently being generated, ventures can then afford to hire their volunteers in an effort to build an effective team, just like the Brooklyn Grange has. Finding the right group of individuals, who possess the diverse set of skills that

are needed to operate such a farm successfully, is a challenging task. That is why having a team of volunteers and a community engaged in the farms early development is essential as it serves as a pool from which future employees can be derived. Peck shares with me that in discussions with both Flanner and Throness regarding their respective projects, a large degree of emphasis was placed on the necessity for management to delegate responsibilities. In an interview with Peck he exclaims, “You can’t do it all!” in an effort to highlight the importance of building a strong team of staff, making the process of building an imperative resource.

Having efficient sales channels is something that Flanner, Throness, and other successful rooftop farming operations have all stressed. In response to asking Flanner what he believed to be a rooftop farm’s most vital non-physical asset, he asserted, “Having efficient sales channels,” he then continued, “The easiest part is growing it, the hardest part is selling it efficiently”. Flanner’s sentiment mirrors what was stated in the literature. When speaking to Throness, she shared some of the sales channels RUF had engaged with, while highlighting which avenues had proven to be the most successful. Although Mandel listed restaurants as a lucrative sales channel for numerous rooftop farms in her book, Throness expressed the difficulty that RUF faced when trying to deliver produce to nearby eateries. Her small team found it much too laborious having to haul produce down to these nearby locations on a regular basis. She did however verify the efficacy of running a weekly CSA program, stating that having customers come to their location to pick up produce each week, was much more manageable to facilitate than having to consistently bring the produce off-site. With all things considered, having an efficient sales channel has proven to be another essential activity that ensures the success of any rooftop farming operation.

Unfortunately, all of the aforementioned resources and activities are absolutely imperative to the success of any open-air rooftop-farming venture. Therefore, if one feels they are unable to

carry out or obtain all of these essential components, it would not be well advised for them to invest in starting such an exacting venture. Being able to diversify one's business, attract volunteers, build a strong effective team, and organize efficient distribution channels have all been deemed vitally important. Some of the following resources may be substituted of forfeited if one is pressed for funding and left with no other options, these will be specified.

In my interview with Flanner he emphasized the importance of the scale of one's location. Scale is something that sets the Brooklyn Grange apart from RUF; having two farms, each with at least an acre in size, inevitably contributing to the Brooklyn Grange's financial viability. He wanted to make clear the fact that there is no golden ratio in terms of calculating the amount of space that is needed to operate an open-air rooftop urban farm successfully. When trying to calculate the amount of space required, it is difficult because there are so many factors to take into consideration: "the market, rent, price of food and your community all that stuff. You definitely need a minimum amount of area in order to generate the amount of revenue needed to keep your business alive. And that makes it a little bit less scalable, because there are only so many buildings like that" (Flanner, Interview 2018). Although this can be a painstaking process, finding a suitable location is an open-air rooftop urban farm's most important physical resource, as it ultimately determines the accessibility of the farm, its overall size, its structural capacity, its malleability, its potential to serve as an event space, and the amount of growing space it can support (Flanner, Interview 2018). Without this space there is no farm; needless to say this is not a resource that can be sacrificed.

The acquisition of an optimal location usually involves perusing Google Maps to see what kind of rooftop space might be available within the city one intends to farm in. To determine which building can be deemed "suitable" one must first do a careful calculation based on: rent prices, cost of installation, average price of produce, utility costs, salaries, and other

operational costs, to work out how much space would be required to generate the necessary amount of revenue (Flanner, Interview 2018). In addition, one must also think about the potential that the space possesses to host a wide variety of events, such as weddings, workshops, photo shoots, and dinner parties. Recognizing this potential and using one's space effectively helps to create the additional revenues streams that are essential in ensuring financial sustainability. Once these calculations have been made and sites have been identified as suitable, in terms of their area, one must then ascertain whether or not sites have the other necessary physical attributes that are key to the success of any rooftop open-air urban farming operation. These assets include an enclosed structure such as a greenhouse, a freight elevator, and a washing station.

Fig. 7. Ryerson's Urban Farm Greenhouse

The physical asset that has come up repeatedly in my research, and has been identified as an invaluable asset to any rooftop urban farm, is a greenhouse. Greenhouses have the ability to foster life within them when the environment outside proves to be inhospitable; allowing for

one's growing season to be extended indefinitely. In which, high-value crops such as micro greens, can be grown year-round in a place like Toronto, where this would otherwise not be possible. Helping farms to generate revenue through what could potentially be their dormant season. It also serves as a space where seedlings can be started prior to being planted in the spring, which also drastically helps to extend an open-air rooftop farm's growing season. That is why Winterer, Throness and Flanner, have all emphasized the necessity for a semi-permanent or permanent crop cover such as a greenhouse, which can drastically help to improve one's growing capability, and in turn, one's profitability. If installing a greenhouse is simply not within one's budget there are a number of other season-extending alternatives that are more affordable. Purchasing the materials needed to install hoop houses, which usually involve an insulated material suspended over one's growing area to protect plants from the cold and frost. While this solution is much less costly, it does not allow for all season growing, nor does it serve as a space where seedlings can be started. These two factors could potentially have a huge impact on the year-round success of one's open-air urban farming operation.

Having a compost heap is another vital resource for any successful open-air rooftop farm. The beautiful thing about composting is that all of the inputs it requires are naturally occurring on any farm. The organic waste that is inevitable by-product of daily farming operations, could be perceived as merely waste that the farm would otherwise have to get rid of via the cities disposal systems, or it could be utilized on-site to produce compost that can then be put back into the soil to ensure soil fertility (Throness, Interview 2018). Otherwise, farmers would have to order more soil amendments and would have to repeatedly pay to ensure the fertility of their soil. It seems an obvious choice to harness the resources that are naturally occurring on the farm to create something that can then be directly applied and utilized to invigorate one's harvest. Throness is a huge proponent of compost and believes it is one of the most important activities that any farm would be foolish not to partake in; as it

provides vital nourishment to the soil that is so integral to a farm's operation. Therefore, it is also important to think about where these composting activities could take place, as a heap should have a minimum mass of one meter squared (Miles, 2015). This was also reiterated by Ryerson's Urban Farm Operations Coordinator, Jayne Miles, during a lecture she gave on *Soil Fertility with Ecological Method,* during their Ryerson Urban Farm Training course.

Given the limited amount of space and the number of operations taking place simultaneously on a rooftop open-air urban farm, the following physical assets have also been proven to be hugely beneficial; the industry professionals consulted for the purpose of this research have made this very clear. While these assets may seem unnecessary to a conventional rural farmer, rooftop urban agriculture requires a specific set of tools in order to be effective in the limited space it has. This list includes a freight elevator, a washing station, and event space. That is why finding a location that either possesses these elements or that can at least be retrofitted to support these assets, is essential. It is also worth noting that some of these elements are much easier to add-on to a built facility then others. A washing station will be much easier to add-on than something like a freight elevator, which is if the building has the structural capacity for it. These features while costly, will payback one's operation over time, for assets like a washing station or freight elevator will enable for much greater productivity (Throness, Interview 2018). An elevator is truly something that cannot be compromised on, as it allows for the accessibility of the farm. Not only will certain people not be able to access the farm without a freight elevator, but bringing heavy materials up to the roof will also become an ongoing challenge for a rooftop farm that does not have an elevator. A washing station is something that could be added on as the business becomes more profitable; essentially one just needs a space that where produce can be rinsed, bunched, and bagged, so that it is ready for distribution. This does not have to be a fancy addition; it can simply be a hose, next to an industrial sized salad spinner on a table. The event space on the other hand has proven to also be a non-negotiable resource for an open-air rooftop farming business.

Based on the numbers I have integrated using financial modelling methods, this event space has proven to be an essential additional revenue source. The only way that this event space could be sacrificed is if another supplementary revenue stream has been theorized, such as offering design and consultation services. However, with community engagement being such an important aspect of open-air rooftop urban farming, excluding some sort of gathering space from the operation would be detracting from its potential social impact.

Together these key resources and activities work symbiotically to ensure the success of any open-air rooftop urban farming operation. The cost of these assets should be taken into consideration at the start of the project as funding is being secured. This becomes especially important if a building is being constructed to include some of these specifications, as it becomes increasingly costly and challenging to add many of these features once the plans have been drafted. This has unfortunately been the case for RUF, as they are currently undergoing expansion of their operation onto a second rooftop. Although they had been invited to participate in the development prior to the building's construction, it seemed it was already too late. They were unable to negotiate the incorporation of a freight elevator into the plans, due to the high cost associated with revaluating the building's blueprints (Throness, Interview 2018).

Partnerships

The primary reason for completing this research was to prove the economic viability of rooftop open-air urban farms as there was consistently lacking evidence in the existing literature. In my preliminary research, having reviewed countless secondary sources on the subject, a definitive answer as to whether or not rooftop urban agriculture was in fact a viable business option could not be found. Evidently, it has become clear that urban open-air farming is not a viable business opportunity on its own. It needs to be coupled with one or

more risk mitigation strategies, like the aforementioned diversification of revenue streams. This conclusion is based on calculations I have made from information gained from industry experts and estimates generated by the Cost Benefit Matrix; this spreadsheet has been attached as an appendix of this document. Another highly effective strategy that is being adopted by numerous rooftop urban farms is the creation of mutually beneficial partnerships. The data I have collected shows that having a strong partnership can help to alleviate some of the pressures that a rooftop farm has to secure funding and generate revenue. The parent company can not only help to fund the operation, but can also reap some of the other benefits that the rooftop farm has to offer, such as public attention or the abundance of fresh produce. The partnerships that are currently the most prevalent are those involving either educational institutions or grocery stores, some examples of these will be detailed below. This is another instance of mutualism that serves not only rooftop farms, but also their partner below.

Like previously noted, one of Toronto's only rooftop farms that exists at a large scale is RUF. Their dependence upon the conjoined education institution is undeniable. When speaking to Throness about the farm's survivability apart from Ryerson University, she said the farm would not exist today without the support of the public institution. Housed in the university's Business Services Department, the institution pays all of the staff's salaries (Throness, Interview 2018). The rooftop farm grew from the relationship that had been built between the school's facilities department and a student led initiative. A groundskeeper working with facilities reached out to this student group, which had already been maintaining and growing food on plots of land on the ground level of the school's campus. He propositioned them to take over the existing green roof as it had fallen into a state of disarray. The partnership was perfect, this student initiative, with the trust and support of the campus facilities department, was able to transform this wild rooftop meadowland into a quarter-acre rooftop farm in 2011. This partnership has served the farm very well and has equally bolstered the university's

reputation, as they are recognized for their work in the realm of food security and sustainability.

Fig. 8. Photo Courtesy of Fenway Farms

I had the privilege of speaking with Mark Winterer about his involvement with Fenway Farms. A 5,000 square foot project that cost upwards of $80,000 to install onto a roof within Fenway Park, the famed baseball stadium in Boston, Massachusetts. Opened in 2015, the farm was a response to the underutilized rooftop space that was an eyesore to the tens of thousands of fans who frequent the stadium. Winterer shared with me the story of how Fenway Farms came to be and he speaks about a very important individual named Linda Henry, the wife of John Henry, owner of Fenway Park. Linda had an interest in urban agriculture, so when talk of converting the underutilized rooftop space began she immediately advocated for including a rooftop farm. She secured the necessary funding to retrofit the roof and so the project was underway. Winterer suggests that the farm would not have happened if it were not for Linda's support; he emphasized the need for this kind of champion, a person who fights for a cause. Today Fenway Farms grow nearly six thousand pounds of produce each year, this produce is used by all of the park's food retailers and the rest is donated to the community. Similarly to RUF, Winterer elucidated that Fenway Farms would not be in existence today if it were not for its relationship to Fenway Park. The stadium offers the farm major exposure, as visitors come to tour the famed stadium on a daily basis, in which the farm is a major attraction. This is another instance that exemplifies the mutually beneficial relationship that urban rooftop farms can have with private organizations and their communities at large.

Just last year in 2017, the franchise grocery store IGA extra Famille Duchemin in Saint-Laurent, Quebec, garnered a lot of attention for opening the largest organic rooftop farm in the country, at 25,000 square feet. They are also the first grocery store in Canada to sell their organically grown produce in their LEED Silver certified store. This particular IGA is owned by Famille Duchemin, the family owned business hopes to inspire other grocery retailers to follow suit. In an effort to limit their dependence on external resources, the farm uses water that is harvested from the store's dehumidification system. The crops atop the roof are arranged in such a way that anyone with an aerial view can read "IGA" in bright green rows of fresh greens. When speaking with owner Francis Duchemin, he explained that they were never too concerned with productivity, although they do supply their grocery store with the freshly grown produce. He suggests the whole thing was done as more of a marketing opportunity. In an interview published in the most recent issue of the Living Architecture Monitor, Duchemin states that, "The customers at the IGA love not only the idea of the plants on the roof, but the availability of in-store super fresh vegetables and herbs… In the era of consumers wanting to buy local, buying vegetables grown on the roof couldn't be more local" (McLean, 2018: 14). This justification speaks volumes, as it speaks to the social value that a rooftop urban farm can bring. The Duchemin family was willing to invest the time and money necessary to build their farm not because they thought they would reap exorbitant amounts of financial return from the produce grown, but rather to gain the social capital that comes along with incorporating such innovative, eco-friendly, socially responsible technology. Their desire to garner social recognition is very much in keeping with what was discovered in the literature. Not only is this example a testament to how a rooftop farm can coalesce with the grocery store below, it also speaks to the potential impact policy can have on ensuing positive progress. This farm is also the result of legislation that was passed by the city of Saint-Laurent, which requires all new constructions to have a minimum of 50% of their rooftop space covered by vegetation (McLean, 2018: 13). This is precisely the kind of favourable

outcome that policy can have, which I alluded to in the literature review chapter of this document.

The Brooklyn Grange also denotes recognizing their social value and the importance of finding like-minded partners who understand the coveted social capital and attention that rooftop urban farms can garner (Plakias, 2016: 59). The recurring theme of a "champion" has become apparent. A champion is a person who believes in the project, who takes it all the way from conception to fruition. Having this champion, whether it is a team of people or one person, who is willing to do whatever it takes to make the project happen, is essential. This is why having a partner in this challenging process alleviates a lot of the stress of starting such a groundbreaking enterprise, such as in the case of Whole Foods and Gotham Greens. Peck suggests that having a purchase agreement between a rooftop farm and a grocery store can also help to facilitate financing, as investors may be more willing to back the operation if they know the produce that is being grown is guaranteed to go to market (Peck, Interview 2018).

Impact Assessment

The viability of sustaining a rooftop open-air urban farm business has been confirmed, again based on the calculations I have formulated with given data, which was ultimately the intention of my research. While this might be sufficient ground for most industries to start a business, this is not the case for rooftop urban agriculture. Unfortunately, starting this kind of enterprise is not just about winning the support of investors it is also contingent upon getting the approval of property owners and building managers alike. Consequently, there needs to be further incentive to sway the support of these gatekeepers who may not otherwise bother with the solicitations of an eager rooftop farmer. Luckily for us, there are a handful of powerful impacts that will help one to win over the support of decision makers.

One benefit that is highly attractive to both property owners and managers, is the fact that installing an intensive green roof such as this, can help to substantially reduce a building's heating and cooling costs in the long term. Open-air rooftop urban farms are built on what is referred to by green roof industry professionals as intensive green roofs. Intensive green roofs consist of much deeper heavier soil and are able to support a much more diverse variety of plant life, like grasses, flowers, shrubs, and even trees (Bass et al., 2013: 9). There are also semi-intensive green roofs and extensive green roofs. Extensive green roofs are certainly the most commonly implemented type green roof; this is due to the fact that they are not as costly, lower maintenance, and require much less structural capacity due to their shallow depth of soil. However, extensive green roofs are not able to support growing vegetable crops and are typically only able to support grasses and sedums. Although, intensive green roofs require a much greater initial capital investment, they also provide more insulation for the building helping to regulate internal temperature, lowering their dependence on heating and cooling systems.

This temperature regulation is dependent upon numerous factors, such as, the size of the roof, the insulating effect of the added material, and the plants natural evapotranspiration process. Evapotranspiration is the process by which water is transferred from the earth to the atmosphere through plants natural water evaporation. A report conducted by Ryerson University cites that, "England et al. (2004) estimated green roof annual energy savings at a value between $2,500 and $12,500." (Banting et al., 2005: 30). This is owing to the fact that most of a building's heat is lost through the roof in the winter; a roof is also the site for the hottest temperatures in the summer. Research done by the National Research Council of Canada found that an extensive green roof reduced the daily energy demand for air conditioning in the summer by more than 75% (Banting et al., 2005: 3). These are important features that any budding rooftop farmer should bring forward with them when approaching

property owners and other decision makers.

Another financially and environmentally savvy benefit of installing this kind of technology onto a rooftop is that it helps to increase a properties ability to manage its own stormwater on site. Stormwater management has become an increasingly pressing issue in recent years, as city's stormwater infrastructure systems continue to deteriorate. Historically, municipalities have relied on merely accruing property taxes to cover these repair costs, however, inadequate funding has created a $6.8 billion stormwater infrastructure deficit in Ontario (What We Need, 2016). As a result, many cities within the province have taken it upon themselves to secure this funding from its inhabitants. The City of Toronto published a five-year action plan in 2003 entitled "Wet Water Flow Master Plan: The Plan in Action" that recommends, "source control" as their preferred stormwater mitigation strategy. Source control refers to dealing with the wet weather flow where it falls, to prevent it from entering the cities stormwater infrastructure systems. Green roofs are a prime example of what is considered source control; this is one reason why the City of Toronto adopted the green roof bylaw in 2009. Similarly, the City of Mississauga implemented a new Stormwater Charge in 2016, which charges property owners for the amount of impermeable surface area they have on their property. The charge also recognizes those who manage stormwater on their own property and accordingly gives them an equivalent charge reduction (Understanding the Stormwater Charge, n.d.). For this reason, in an increasing number of municipalities, proposing a green roof is seen as a huge advantage for most property owners, as it could end up saving them tens of thousands of dollars over the course of consecutive years. For example, a calculation done using the Cost Benefit Matrix tool indicates that 10,000 square feet of green roof would be an annual energy savings of about $1,600.

Extending the life of one's roof membrane is another attractive benefit of installing a green roof. While a conventional roof lasts anywhere between fifteen to twenty years, a green roof

will typically last for more than forty years; thereby doubling the lifespan of one's roof (Pevzner, 2013: 18). This benefit in conjunction with the knowledge that a prospective installation site may be due for a roof replacement could be a very effective sales strategy (Tamlin, Interview 2018). If one were to approach the owners of an older building in need of a new roof, the partnership would be even more mutually beneficial. Rooftop farming entrepreneurs could encourage building owners to invest the money that they were planning to spend on replacing their old conventional roof in the rooftop farm project. This has the potential to be a very effective strategy, which could help entrepreneurs to secure additional funding. While offering to double the lifespan of a property owner's roof, with the added bonus of capturing stormwater on-site and lowering the utility costs of the building

These benefits when coupled with the financial viability of the ongoing business make rooftop open-air urban farming a guaranteed formula for success. As a new venture it is important to know what value you bring. This value includes, but is not limited to, fresh local produce, lowered utility costs, increased public engagement, and prolonged roof membrane durability. Although this process will involve asking people for permission, support, capital, and other investment, it will also involve offering the highly attractive aforementioned benefits.

Business Model Design

All of these findings clearly come together through the use of the Business Model Canvas tool, which I was referring to earlier in the Research Methodology portion of this paper. Taking both what was derived from my literature and the data that was derived from conducting interviews I have been able to paint the picture for what a successful open-air rooftop urban agriculture business looks like. In an effort to clearly understand and

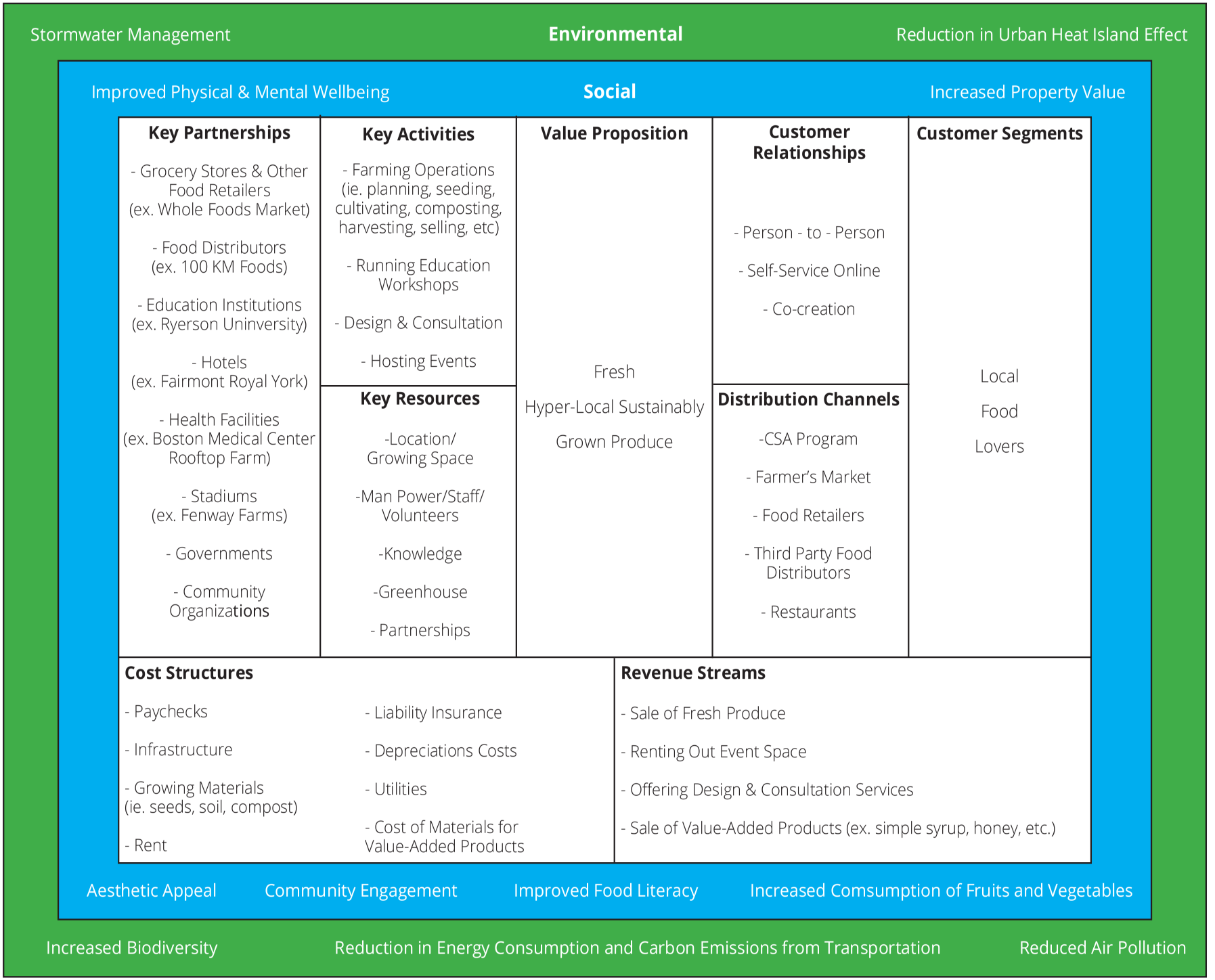

Fig. 9. Business Model Canvas

communicate what exactly the business's key customers, primary offer, necessary infrastructure, and financial viability is through its nine major building blocks: Customer Segments, Value Proposition, Distribution Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, and Cost Structure.

At the heart of this BMC are the Primary Customer Segment and Primary Value Proposition that is offered by open-air rooftop urban agriculture businesses, which are Local Produce Lovers and the Fresh Hyper-Local Sustainably Grown Produce that they desire. It is evident that there has been a growing demand for nourishing food that has not been grown, as was suggested by monsieur Duchemin in an interview highlighting the development of their grocery's store's very own certified organic rooftop farm (McLean, 2018: 14). These customers can access this produce by visiting farmer's markets, subscribing to a CSA program, purchasing at nearby food retailers, or by dining at restaurants that are lucky enough to receive this coveted product. While most of these Customer Relationships involve personal assistance, customers can subscribe to CSA programs online and are also encouraged to co-create by inviting a range of events and activations to happen within their event space. Therefore, Revenue Streams are diverse by nature, but predominantly involve the sale of assets, such as fresh produce or value-added products. These value-added products can include a long list of things; such as hot sauces, mustards, honeys, simple syrups, jams or fermented foods. The list is truly endless. For instance, Ripple Farms Inc., which is a small aquaponics operation that has been gaining momentum here in Toronto, sell their very own simple syrup that they make from slightly damaged, misshapen, discoloured basil that they might not otherwise sell (Interview, Hebor 2018). This is a prime example of how these tight budget businesses can optimize their assets, to ensure they get the most value out of their production. Additional revenue is also brought in through event space rentals. Rooftop farms have proven to be desirable spaces, as they offer a lush and beautiful setting within the concrete urban landscape. These spaces are unique and their novelty certainly

adds to their allure. So what happens when these events spaces become less scarce in the future as more rooftop farming operations proliferate across the city? Practitioners may then begin to capitalize on their expertise by offering others their design and consultation skills to help expand the industry of open-air rooftop urban agriculture. While one revenue stream may dwindle another emerges.

All of this would not be possible without the inclusion of some previously identified Key Resources, such as manpower, growing space, and knowledge to name a few, which work in conjunction with the Key Activities that have been deemed essential to the business's ongoing success. Some of these activities include farming, education, hosting events, and offering design and consultation services. This is all made possible through the establishment and ongoing maintenance of mutually beneficial Partnerships. In the same way that rooftop farms benefit the buildings they inhabit by reducing their dependence on heating and cooling services, open-air rooftop farms provide an abundance of benefits for cities and their governing bodies. These include both the social and environmental impacts that I have made reference to throughout; such as stormwater management, reduced urban heat island effect, reduction in energy consumption and carbon emissions, reduced air pollution, increased property value, improved food literacy, community engagement, improved mental and physical wellbeing, and more. In the same way that landlords enable the construction of these developments, governments and the policies they implement can encourage the development of the rooftop urban agriculture industry. Both governments and other partners can provide their support in more ways than one; they can lend their support through advocacy, funding, and in terms of granting space too!

The last piece and arguably the most important is all of the costs that are incurred from the operation of such a business model. Something that had become evident was the high-cost involved with running such an open-air rooftop farm; it requires expensive infrastructure, it

Set-Up Costs		**Expenses**		Revenue	
Installation Costs	1,505,039	Salaries	$551,000	Food Production	$261,250
Fences, Ramp, Event Space, Greenhouse	$625,000	Volunteers	$8,000	Sale of Value-Added Products	$5,918
Freight Elevator	$110,000	Compost	$6,250		
Legal Fees	$7,500	Seeds	$6,000	Sale of Honey	$1,600
Permits	2,500	Farmer's Market Stall	$945		
Apiary - Bees	$800	Depreciation Costs	$212,605	Consultation Services – Design & Installation	$7,838
Eco-Roof Incentive Program	($50,000)	Liability Insurance	$7,500	Event Space Rental	$662,500
Other Grants	($75,000)	**Total Expenses**	**$788,300**		
				Total Revenue	**$939,106**
Net Assets	**$2,126,053**	**Profit (Loss)**	**$150,805**		

Fig. 10. Financial Modelling for the Open-Air Rooftop Farm

is extremely labour intensive, and there is also the expected added expense of acquiring the necessary agricultural materials in a city, high above street level, on a rooftop. While this high-cost business model was understood, what was lacking were the hard numbers, the financials, the expenses clearly balanced out against the revenues. Understanding this Cost Structure and contrasting this against Revenue Streams, which had both been informed by data collection, was the overall intention of my research as it would ultimately either confirm or deny the financial sustainability of open-air rooftop farming businesses.

While the Business Model Canvas tool helped me to clearly convey the function of any open-air rooftop urban farm, with all of its moving pieces, what was still left to uncover was a rigorous unpacking of their financials. This was the piece that was perpetually underrepresented in the literature. That is why I took it upon myself to employ financial modelling tools to either prove or disprove open-air rooftop urban agriculture business's ability to produce a financial return in the long term. This was the primary aim of my research, as I sought to determine the financial sustainability of open-air rooftop urban agriculture businesses. For these reasons I felt it necessary to employ the financial modelling tools that would enable me to fulfill the ultimate intention of my research.

You may note that many of these inputs are ones that have already referenced; now here one can actually see how much these things cost and the answer is a lot! Even with the eco-roof incentive that the City of Toronto offers, the set-up will still cost upwards of two million dollars to install the infrastructure that has been deemed necessary through my research. Many of the numbers were derived using the aforementioned Cost Benefit Matrix tool, all other financial details were provided by the industry professionals who I was fortunate enough to be in conversation with. More details about how and where these numbers were derived from can be found in the appendix of this document.

As you can see here, the greatest expense involved in such an operation is labour, which coincides with what was stated by Throness in an interview. Finally we can now recognize the necessity of the event space as the profit driver, much more so than the sale of fresh produce. Therefore, this business would not be viable without both of these revenue streams, which is ultimately what I was looking to determine. While an event space does seem to be an essential addition to the business model, another revenue stream can be substituted if its efficacy has been proven. Nevertheless, this model that I have painstakingly designed serves as a model that can serve as a starting point for those who are looking to establish their own open-air rooftop urban farming venture.

Conclusion

It was the overall intention of my research to make clear the financial feasibility of operating an open-air rooftop urban farm. It had become clear to me as I was undergoing my literature review that the economic activities of those operating in the field seemed to be shrouded in mystery. These businesses had no information publicly available, making it very hard for one to determine if they were in fact turning a profit. My research has involved conducting in-depth interviews with handpicked industry professionals in order to derive this hard to find information. While I was able to derive some financial details from most of the organizations I engaged with, these figures were sporadic and limited at best. Regardless of this, the piecemeal of economic information I was provided was assembled using various modelling tools: the Business Model Canvas, the Cost Benefit Matrix Tool and financial modelling principles. Together they helped to paint a clearer picture of what an open-air rooftop farms sustainable business model actually looks like; ultimately enabling me to determine the economic feasibility of an open-air rooftop farming business, which was the overall aim of my research.

This process has been extremely telling. I have come to the conclusion that while the social and environmental efforts of open-air rooftop urban agriculture have been substantiated, there is simply not enough evidence to suggest that such a business could operate on the sale of produce alone. It has become clear that open-air rooftop urban agriculture must be paired with another entity, such as a school or food retailer, or must be bolstered by activities beyond merely the production and sale of fresh produce. Therefore, those looking to get into the open-air rooftop farming industry must realize the need for these various facets. The farm will take on forms beyond what traditional agriculture has served in the past. Open-air rooftop urban farms must also be spaces for education and events. Rooftop farmers should also be prepared to lend their knowledge speaking at events and working as consultants to help others to design and install rooftop farms of their own. That being said, if all of these amendments are consolidated successfully an open-air rooftop urban farm has the potential to be a sustainable business.

The sharing of knowledge and the growing prevalence of resources is making this model more affordable, more scalable, and more attainable. There is a responsibility amongst practitioners to share their knowledge, to create a network of individuals that make up our urban food landscape. This indeed is a sentiment that is shared by many, as stated very clearly in an interview with Throness, “There is an opportunity to share back and forth” (Throness, Interview 2018). This ecosystem is an essential part of the future of our food systems, neither open-air rooftop farms nor more highly technological farms can progress this industry alone (Peck, Interview 2018). Together these models can create the visibility and productivity needed to educate and feed our growing cities.

It is essential that rooftop farmers are aware of what value these projects will bring to investors, property owners, city dwellers, and farm-hands alike. It is about knowing what the necessary elements are to succeed and leveraging one’s assets well. It is like Ben Flanners

said in our interview, “it just needs to be run tightly, with a lot of passion, it’s not something to just dabble in, you’ve got to give 110%.” It takes a certain kind of person to run an open-air rooftop farm, this is not to say that they have to have studied agriculture, or economics, or engineering; rather it takes a certain level of dedication and determination to reap such success. It is about bringing together the right people, with the right resources, and creating an airtight business plan that will draw in investors and partners alike.

This is an integral part of the future of our food systems. Those with the foresight to see beyond merely the cost benefit analysis, to see the bigger picture will be amongst those early adopters who propel this technology forward. Inevitably the majority will follow suit and see the value of these systems, as the necessity becomes more pressing. Laggards too will be won over, once the rooftop-grown produce inevitably becomes more widely available, ending up on their plate without their knowledge. The seeds of this movement have been planted; it is time to foster the seedlings, which are the abundance of budding rooftop urban agriculture operations that are entering the market, to ensure that they grow into strong viable enterprises.

Next Steps

A limitation of my research was certainly the fact that I was only able to interview a small number of practising rooftop farmers and no one working at a larger-scale high-tech operation. It would have been valuable to interview someone from this more technological sect as it could have provided an opposing view to my research, giving it more depth and breadth. Certainly, if given the time and resources I would have made a point of going to visit one of these farms, but unfortunately none of them are currently operating within Ontario. Similarly, speaking more research subjects working in open-air rooftop urban agriculture would have allowed my research to be more comprehensive.

In the future, I theorize a survey could be administered inquiring about various financial and operational details, such as the number of employees, total expenses, revenue sources and more. This information could be compiled to create a visual representation of the main elements of these major operations, to give a clearer scope of the industry. Perhaps this may have to be done by a more recognized researcher or reputable organization, so that the survey is taken seriously and so businesses would feel more inclined to participate. This proposition is based on the fact that many of these large rooftop urban farming organizations would not entertain my request for a brief interview.

This visual representation could then serve as a tangible tool that both industry professionals and those looking to get involved could refer to. This is precisely the kind of knowledge sharing that many feel is necessary to progress the industry (Throness, Interview 2018). Conceivably, it could even be a working document or artefact that could be added to as these dynamic businesses grow and adapt. So as to serve as a constant reflection of the current practises of the industry, ultimately helping to establish best practises for the emerging industry of rooftop urban agriculture.

Fig. 11. Photo of the Brooklyn Grange Courtesy of Stephanie Brauer

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Appendix A – Financial Breakdown

Assets - Including Set-up costs (initial 6 months)

Catgeory	Low Forecast	High Forecast	Average
Installation Costs (Generated by Cost Benefit Matrix includes: design, admin, initial structural evaluation, filter cloth, membrane , drainage, growing medium, vegetation, installation, walkways, borders, and irrigation)	$ 1,204,031	$ 1,806,047	$ 1,505,039
Permits	$ 1,000	$ 4,000	$ 2,500
Food Handler Certificate (Provided by City of Toronto)	$ 197	$ 231	$ 214
Legal Fees	$ 5,000	$ 10,000	$ 7,500
Apiary (Based on price from Alvéole)	$ 300	$ 1,300	$ 800
Freight Elevator (Estimate Provided by Otis Elevator Company)	$ 65,000	$ 75,000	$ 70,000
Fences, Wash Station, Green House, Gathering Space, Ramp, Events Gathering Space - (Based on # provided by RUF)	$ 250,000	$ 1,000,000	$ 625,000
Eco Roof Incentive Program	$ -	$ (100,000)	$ (50,000)
Other Government Grants (Estimated)	$ (50,000)	$ (100,000)	$ (75,000)
Net Assets	**$ 1,475,528**	**$ 2,696,578**	**$ 2,086,053**

Useful life span of this initial investment is 10 years, therefore, this initial investment will be depreciated over 10 years. I have built this model based on findings from literature and from the data I have derived from expert interviews.

Financial Plan (Profit and Loss) - Year 1

Calculations based on 40,000 sq/ft space	Low Forecast	High Forecast	Average
Revenue			
Food Production (Estimate generated by Cost Benefit Matrix, substantiated by careful calculations of crop plan for 40,000 sq./ft. growing space)	$ 47,500	$ 475,000	$ 261,250
Sale of Value Added Product (Based on information provided by Brandon Hebor from Ripple Farms Inc.) (Simple Syrup by Ripple Farms (Simple Syrup retails for $15-$20 > Equivalent of Lime Basil would be $3 and Honey is about $5 for that volume (@ wholesale we pay $2) Simply put, $5 in raw + $1.25 jar + $.25 label + Labour = $8.50)(Low Based on current sales of 50 bottles a month at $15 and high is based on %15 stipulated growth at $20)	$ 3,900	$ 7,935	$ 5,918
Sale of Honey (Estimate provided by Arlene Throness from RUF)			$ 1,600
Consultation Services - Design and Installation (Based on information provided by Mark Winterer from Recover Green Roofs, LLC)	$ 6,296	$ 9,380	$ 7,838
Event Space (Based on information provided by Ben Flanner from Brooklyn Grange - 115 outdoor events in their 2,000 sq ft event space)(Low estimate based on 100 3-hour events with up to 75 guests + 15 3-hour events with up to 150 guests and high is based on 100 full-day events with up to 75 guests and 15 full-day events with up to 150 guests)	$ 325,000	$ 1,000,000	$ 662,500
Total Revenue	**$ 382,696**	**$ 1,492,315**	**$ 939,106**
Expenses			
Salaries (Low based on employing 5 people at $50,000 and High is 10 people at $70,000)	$ 290,000	$ 812,000	$ 551,000
Volunteers (Low based on an allowance of$100/Month X 8 Month for 8 people and High is 12)	$ 6,400	$ 9,600	$ 8,000
Compost (Estimate provided by Arlene Throness from Ryerson Urban Farm)	$ 2,500	$ 10,000	$ 6,250
Seeds (Based on price from Johnny Selected Seeds)	$ 4,000	$ 8,000	$ 6,000
Farmer's Market Stall Annual Cost (Based on Toronto Farmer's Market)	$ 923	$ 967	$ 945
Depreciation costs	$ 147,553	$ 269,658	$ 208,605
Liability Insurance (Estimate provided by Jenna Mckay from BrokerLink)	$ 5,000	$ 10,000	$ 7,500
Crop insurance/CSA not suitable for 1st year	$ -	$ -	$ -
Total Expenses	**$ 456,376**	**$ 1,120,224**	**$ 788,300**
Profit (Loss)	**$ (73,680)**	**$ 372,091**	**$ 150,805**

Food Production

Crop plan for 40,000 sq/ft space with total of 100 beds at 100ft in length,
10 beds were planned out conservatively and then multiplied by 10 to create an estimate.
Crop x Bed Length (100ft) x Yield per ft x Rows per bed x Plantings per Seasons x Cost = Value

	Crop	Bed Length in ft	Yield per ft	Rows per bed	Plantings per Seasons	Sale Price	# of Beds	Value
1	Cabbage	100	0.67	2	3	$ 4.00	10	$ 16,080.00
2	Lettuce	100	1	3	6	$ 3.00	10	$ 54,000.00
3	Eggplant	100	1.1	2	3	$ 1.00	10	$ 6,600.00
4	Winter Squash	100	1	1	2	$ 4.00	10	$ 8,000.00
5	Spinach	100	0.35	3	4	$ 5.00	10	$ 21,000.00
6	Beets	100	0.5	3	3	$ 3.00	10	$ 13,500.00
7	Garlic	100	2	3	1	$ 2.00	10	$ 12,000.00
8	Basil	100	1	3	3	$ 2.00	10	$ 18,000.00
9	Cilantro	100	1	3	3	$ 2.00	10	$ 18,000.00
10	Beans	100	0.55	2	3	$ 4.00	10	$ 13,200.00
11	Tomatoes (greenhouse)	50	2.2	1	8	$ 2.50	4	$ 8,800.00
							Total	**$ 189,180.00**
	Deduct 30% from this total to account for losses, a general rule taught by Jayne Miles during the Ryeron Urban Training Course.						(-30%)	$ 132,426.00

Consultation Services

Example Provided by Recover Green Roofs, LLC (2012)	**Price**
Green Roof & Installation Costs	$ 315,000.00
Ballasted Green Roof Anchors for Temporary Seasonal Plastic Coverings	$ 7,500.00
Railings Scope of Work and Costs	$ 65,000.00
Rainwater Harvesting Tanks Scope of Work and Costs	$ 74,500.00
Annual Green Roof Systems Maintenance	$ 7,000.00
Total Revenue	$ 469,000.00
Net Profit (2%)	**$ 9,380.00**

Example Provided by Recover Green Roofs, LLC (2016)	
Total Materials	$ 83,220.00
Total Labour	$ 72,432.00
Total Fixed Costs	$ 155,652.00
Recover Annual System Maintenance	$ 3,500.00
Total Revenue	$ 314,804.00
Net Profit (2%)	**$ 6,296.08**

<u>Public and Private Impacts</u> (Cost Benefit Matrix based on a 40,000 sq/ft space)

Variable	Low Estimate
Storm Water Management	$ 5,763.91
Energy Savings	$ 6,915.46
Heat Island Reduction	$ 9,931.72
Jobs Created ($56,666 in spending creates 1 job)	50